TECHNICAL REPORT
71-38-FL

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CONTROLLED ENVIRONMENT FACILITY FOR DEVELOPMENT OF MILITARY RATIONS

by

John Swift

January 1971

UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760

U.S. ARMY MATERIEL COMMAND

Food Laboratory
FL 127

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13. ABSTRACT

The U.S. Army Natick Laboratories has designed and built a controlled environment facility to develop special rations under virtually germ-free conditions. Airborne contamination is removed by a unique application of absolute filters with the filtered air being focused on the food whenever it is handled. The facility covers 1000 square feet of floor area and was erected and completely equipped at a cost of $90,000. A 4000 square foot mezzanine was installed at a cost of $25,000 to provide the necessary floor area.

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FOREWORD

Food can be prepared in a clean room or controlled environment facility without contributing to its microbiological contamination. Therefore, it can be expected that such foods will require less drastic heat processing than those prepared under conventional conditions. Thus, the flavor characteristics of clean room foods are superior. A facility to exploit this situation has been designed by and erected at the U.S. Army Natick Laboratories. It was funded by NASA, the Air Force, and the Army Materiel Command.

The basic space and equipment requirements were established by the Process Development Division of the Food Laboratory. Specifications were prepared by the Facilities Engineer and contractual negotiations were handled by the Procurement and Contracting Division. The author wishes to acknowledge the cooperation and support of these groups - particularly the Facilities Engineer services group, headed by Mr. Nags. Acknowledgement is also due Dr. R.M. Stinchfield for his guidance and assistance with technical problems; Mr. E.M. Powers of the Microbiology Division, Food Laboratory for his assistance in evaluating the airborne contamination in a test installation; and to Major R.L. Flentge, the Air Force Liaison Officer, for his expression of interest and support of the project.

ABSTRACT

The U.S. Army Natick Laboratories has designed and built a controlled environment facility to develop special rations under virtually germ-free conditions. Airborne contamination is removed by a unique application of absolute filters with the filtered air being focused on the food whenever it is handled. The facility covers 1,000 square feet of floor area and was erected and completely equipped at a cost of $90,900. A four-thousand square foot mezzanine was installed at a cost of $25,000. to provide the necessary floor area.

LIST OF FIGURES

1. INTRODUCTION

This article focuses attention on the design, layout, construction and cost of a clean room or controlled-environment facility at the Natick Laboratories. It was engineered, built and equipped to develop special rations under conditions which approach sterility. The functional objective is to handle, formulate, and process food materials without contributing to the microbiological load. Minimizing the microbiological load may permit a reduction in the severity of thermal processing and an increase in storage stability for those products such as freeze-dried items which are not subjected to heat treatment after drying. A strategic combination of proven contamination control methods have been incorporated in the design of the Natick Laboratories facility. The selected combination makes it possible to achieve the desired objective.

This controlled environment facility offers a unique combination of features in design, operational flexibility, layout and cost. There were numerous problems but all were interesting and challenging. Anyone contemplating the construction of a clean room or controlled environment facility can profit by our experience and may find our approach and answers to problems instructive.

In the course of this article the rationale of the design will be discussed as will constructional features and costs. A flow diagram, photographs, and other illustrations are provided at appropriate points.

Basic steps:

Before proceeding with a detailed discussion we should take a quick look at the operations that occur as raw materials are converted to finished products. The accompanying block flow diagram - Fig. 1, p. 2 , will be useful in visualizing the steps.

A glance at Fig. 1, shows five basic steps in the conversion of raw materials in the controlled environment facility at Natick Laboratories. In each of these steps the biological contamination is either held at a constant level or substantially reduced. In Steps 1, 2 and 3, the count is preserved at or near the as-received level, overwhich incidentally, we have no direct control. It is preserved at this level by storing in sanitized containers under conditions which inhibit the growth of micro-organisms. Step 4, always involves a heating or cooking operation where the enzymes are destroyed and all but the more resistant organism are virtually eliminated. From this point on, particular care is taken to maintain the attenuated level. This applies in particular, to finishing and packaging operations in Step 5.

Figure 1: <u>CONVERSION OF RAW MATERIALS</u>

Step I	Transfer to sanitized containers on delivery from suppliers. Transfer is made in front of filter unit in conventional surroundings.	←	Sanitized containers
Step II	Materials in covered containers moved to pantry for storage. Pantry is semi-clean area.		
Step III	Measured amounts of raw materials in covered containers moved into clean Processing area by means of pass-thru tunnel.		
Step IV	Ingredients blended in front of filter unit and finally subjected to a cooking operation.	←	Heat
Step V	Semi-finished product chilled to -30°F. and freeze-dried at 400 microns. Finally cut, pressed and packaged in front of filter unit.	←	Sanitized containers

2. DESIGN CONSIDERATIONS

There are three basic configurations for controlling airborne contamination - horizontal, and vertical laminar flow rooms, and ordinary rooms with horizontal or vertical laminar flow work stations. In each of these cases contamination is controlled by flushing the work space with essentially dirt and bacteria free air. Our choice was a variation of the latter configuration since it best satisfies our particular needs. The variation involves the use of wall-type filter units with separate stainless steel work tables and the use of HEPA filters in the air conditioning system. The filter units are mounted side by side on stainless steel shelving with the work tables directly in front. Figure 2, p.4 shows one group of four, which is located in the Processing area. The advantages of this arrangement are:

1. Horizontal laminar flow air is focused on the spot where unit operations are performed.

2. Contamination from an operator is directed away from the material being processed.

3. Housekeeping and sanitizing procedures are simplified since the shelving and tables are open underneath and since the tables can be readily moved.

4. Prime filtration area is provided without complicating the room design.

FIGURE 2: Processing Area

Each of the filter units was fitted with a locally fabricated, 3-sided plastic film shield. Its purpose was to eliminate eddy currents around the periphery of the filter. The shield is draped in the form of a tunnel 2 feet high and 4 feet wide, which encloses the work area for a distance of 18 inches from the face of the filter. The shields are made of clear 2-mil polyvinychloride with a loop on each end to hold a ½-inch diameter solid metal rod. The weight of the rod insures a wrinkle-free drape. A unique advantage of the plastic shields is that they can be made to span any number of filter units so that the side-to-side dimension can be changed to suit the need.

Testing the filters:

Before committing ourselves to wall-type filter units we decided to check their performance by means of a pilot installation, the details of its construction being as follows:

> A temporary room was constructed of 2-by 3-inch studding and covered with polyethylene film. A flap of weighted plastic film served for the door. The dimensions of the room were 10 feet wide, 17 feet long and 8 feet high. To test the wall-type units, three 2- by 4-foot filters were placed inside, and samples of air were taken with and without the units in operation. The face area of the three filter units was 24 sq. ft. or the equivalent of 1 sq. ft. for every 57 cu. ft. of room volume.

Airborne contamination was measured on samples which were collected each hour for six-hour periods with a Reynier air-slit sampler. Samples were taken at table-top level in the geometric center of the room. A third set of samples were taken of the air in the surrounding room outside the pilot installation. The averaged results for a number of hourly samples for each situation are shown in Fig. 3, p. 6.

No microbiological contamination was found in the samples taken inside with the filters in operation. The significantly higher counts for the outside sample and the inside sample with the filters shutdown conclusively demonstrates the effectiveness of the horizontal laminar flow filter units. Note that the samples with no microbiological contamination were taken at the center of the room, not at the shielded work area directly in from of the filters. If the air is clean about four feet away, it must certainly be clean close to the face of the filters.

A confirmatory test was made by exposing tryptic soy agar plates for three consecutive two-hour periods inside and outside the test facility. These were cultured to show the contamination which may have been deposited by gravity.

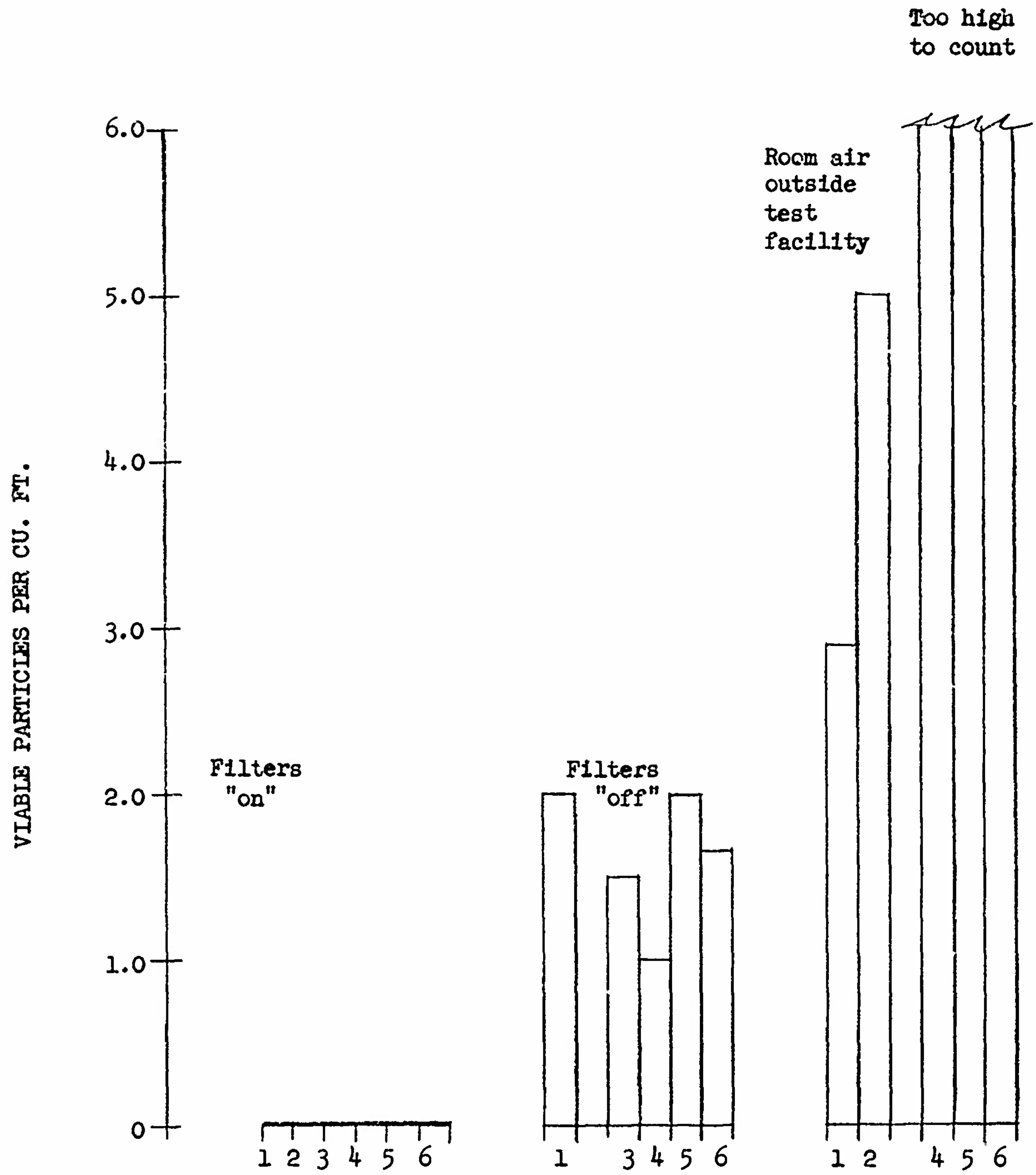

FIGURE 3: MICROBIAL CONTAMINATION INSIDE AND OUTSIDE TEST FACILITY

Figure 4, p. 8 , shows the results of this test. Again, the differences between the high level inside when the filters are off and the virtual absence of contamination when the filter units are operating, is dramatic.

We concluded from these combined results, that wall-type filter units could be used in a permanent facility to provide a microbiologically clean environment providing the ratio of filter area to room volume was 1 to 57 or less.

Other Design Factors:

Our guide for other basic design factors such as intensity of lighting, volume of make-up air, recirculation rate of room air and static pressure differential was Federal Standard 209a.

Area and Layout:

The controlled environment facility at Natick Laboratories covers approximately 1,000 sq. ft. of floor surface. Individual areas and their functional use are as follows:

FUNCTIONAL USE	APPROXIMATE AREA (square feet)
Air Shower	13
Pantry	115
Change Room	50
Airlock	14
Processing	620
Finishing-Packaging	193
Pass-Thru	11

The designated functional use of the separate areas is self-explanatory, but perhaps a few additional comments are in order.

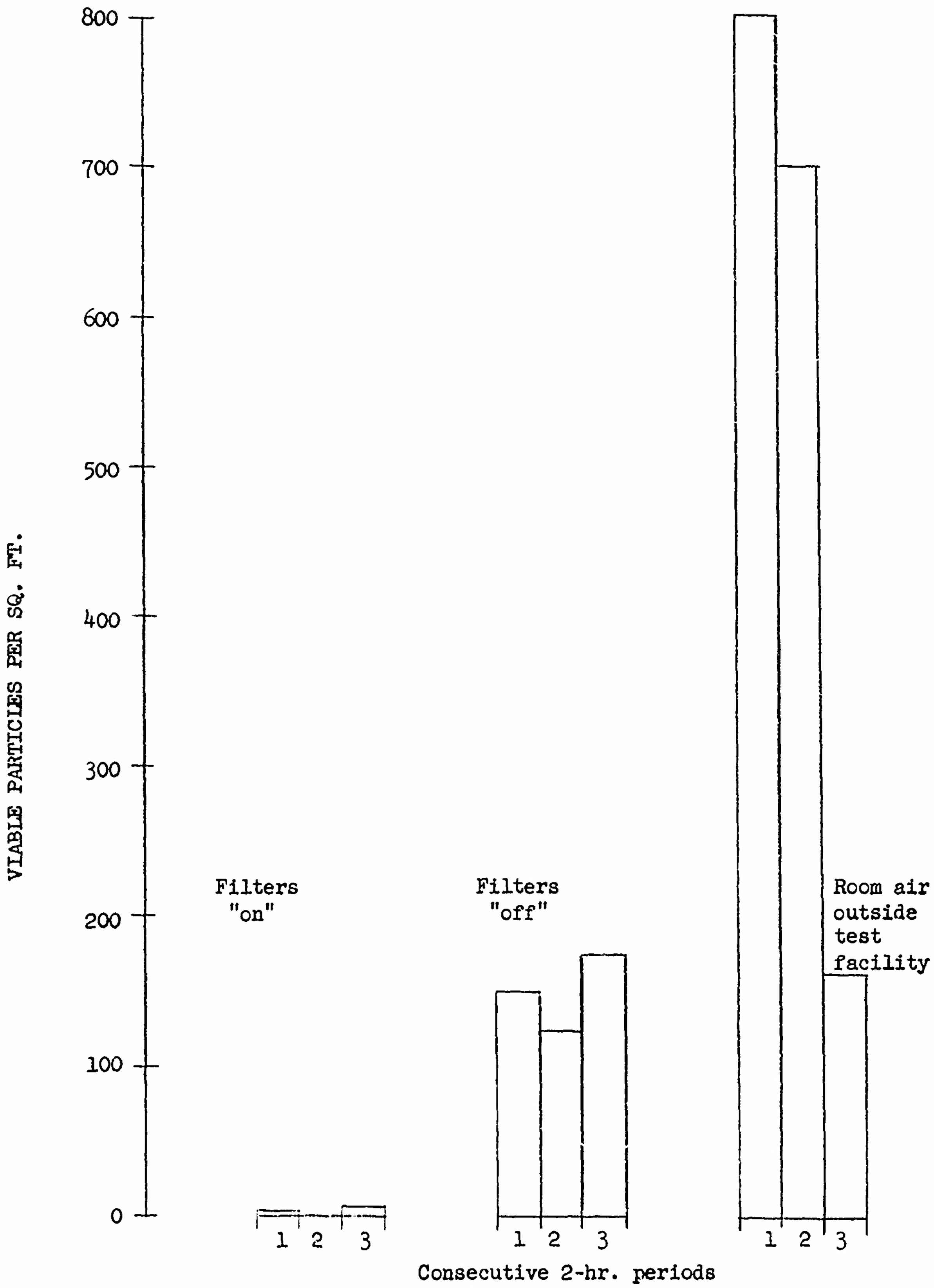

FIGURE 4: MICROBIAL FALLOUT ON TRYPTIC SOY AGAR PLATES

The Air Shower is of conventional design and is only large enough to accommodate a single individual. Figure 5, p.10, shows the outside access door and Figure 6, p.11, the interior. It is equipped with a 0- to 60-second timer and a Magnehelix pressure gauge. The control circuit is relatively simple. The blowers are manually started by means of a push-button on the inside with the period of operation being set by the timer. The blowers, however, can be stopped at any time by pushing a stop-button or by opening a door. The fourteen adjustable nozzles deliver filtered air at an average velocity of 8,000 FPM.

The Pantry is used for the storage of ingredients and for the mixing of materials which are subsequently to be sterilized with heat. It is a semi-clean area throughwhich all materials are funneled in moving from the outside to either the Processing or Finishing areas. The conditioned air which enters the room is introduced through 2-by 4-foot absolute filters in the ceiling. Figure 7, p.12 shows the interior.

The Change Room (Figure 8, p.13) is also designed for occupancy by only one person at a time. It is a semi-clean area with the conditioned air like the pantry being introduced through a 2-by 4-foot absolute filter in the ceiling. The air return grille is positioned to provide a down-flow pattern over the garment rack.

The Airlock serves as a means to move equipment in and out of the facility without losing the isolation of the clean area from its surroundings. Dirty equipment is moved into the lock from the inside and retrieved from the Equipment Cleaning area on the opposite side. The reverse procedure is followed after the item is cleaned and sanitized. Figure 9, p. 14 shows the outside door in the Equipment Cleaning area.

The Processing and the Finishing-Packaging areas are maintained as microbiologically clean as sanitizing procedures and absolute air filtration will permit. It is in these two areas where operations are performed to reduce the microbiological level in food materials and where maximum care is taken to prevent recontamination. See Figures 10, p. 15 and 11, p.16.

The Pass-Thru connects the pantry with the Processing area. It is large enough to accommodate a standard sized tote cart. The doors are made of plexiglass to facilitate inspection and sanitation without the need for internal lighting.

Figure 12, p. 17 shows the orientation of these various areas.

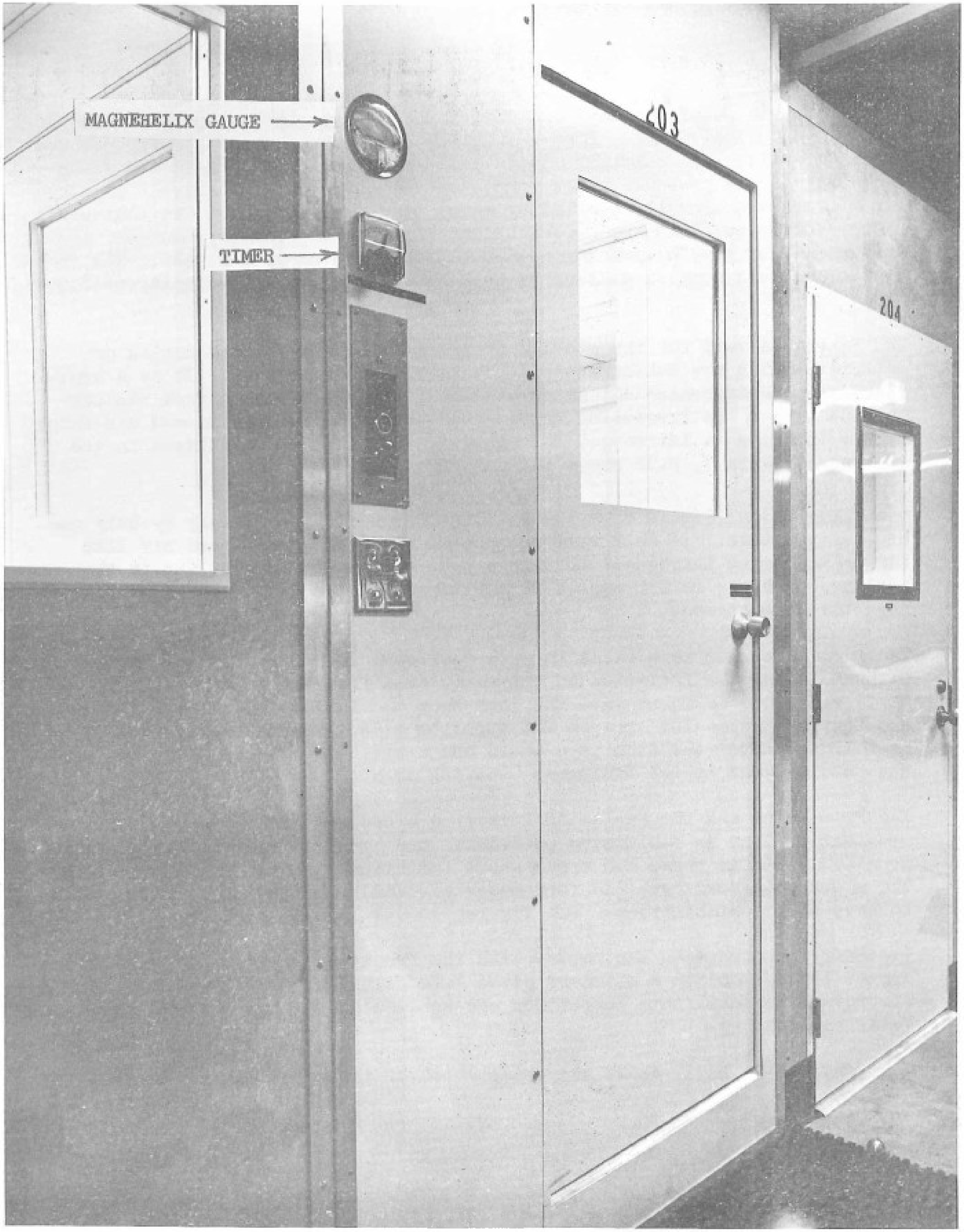

FIGURE 5: Entrance to Air Shower

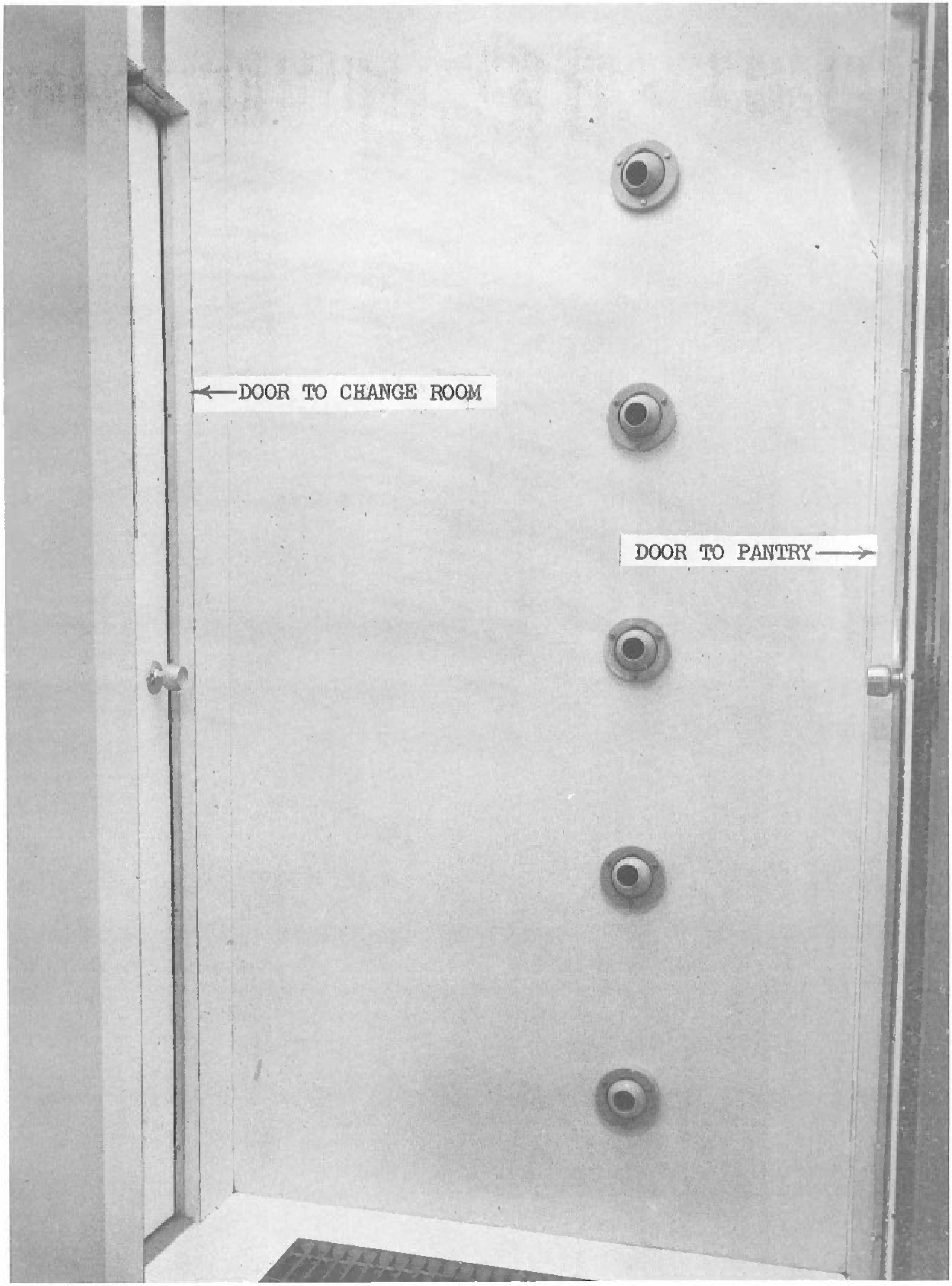

FIGURE 6: Interior of Air Shower

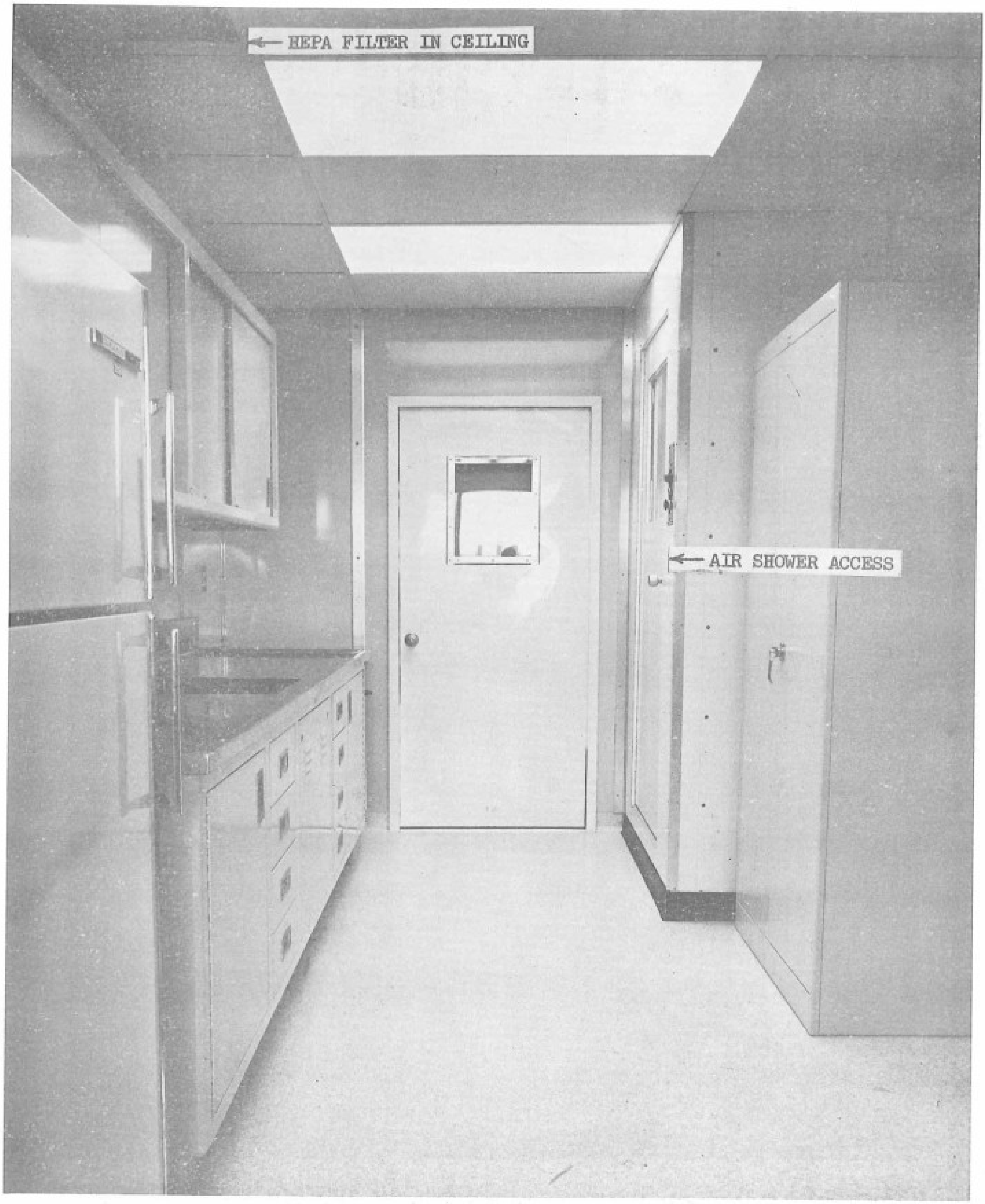

FIGURE 7: Pantry Area

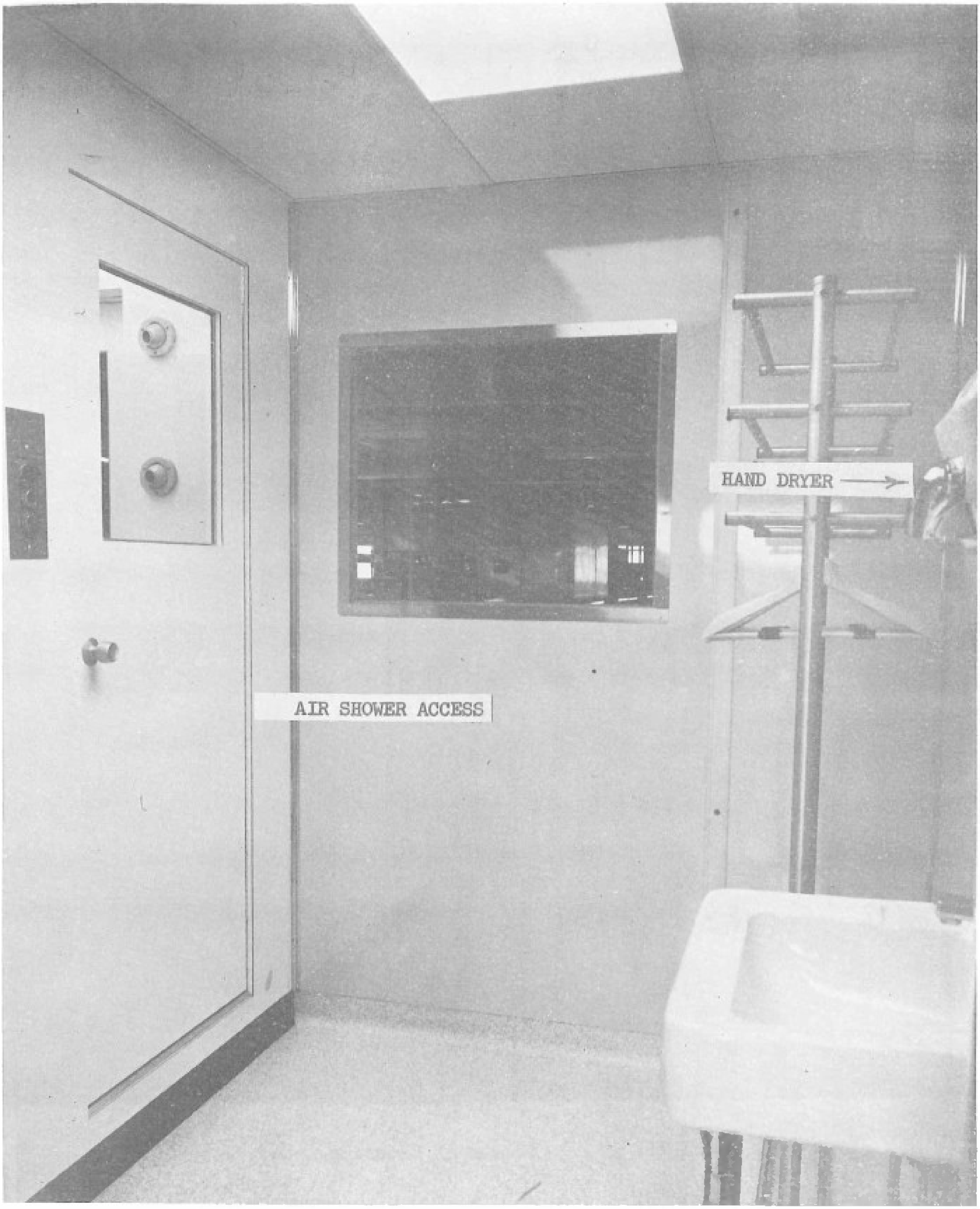

FIGURE 8: Change Room

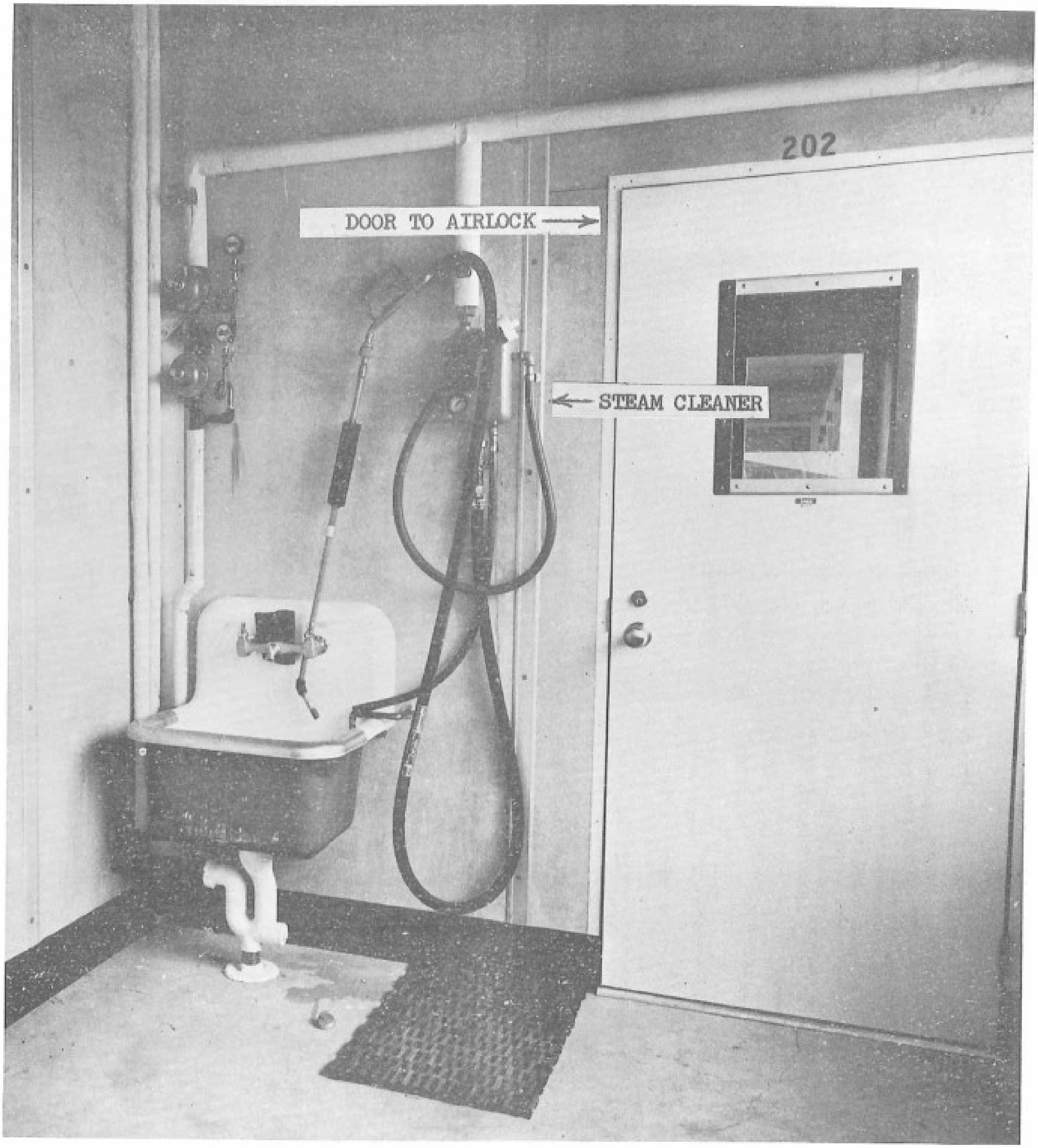

FIGURE 9: EQuipment Cleaning Area

FIGURE 10: Processing Area

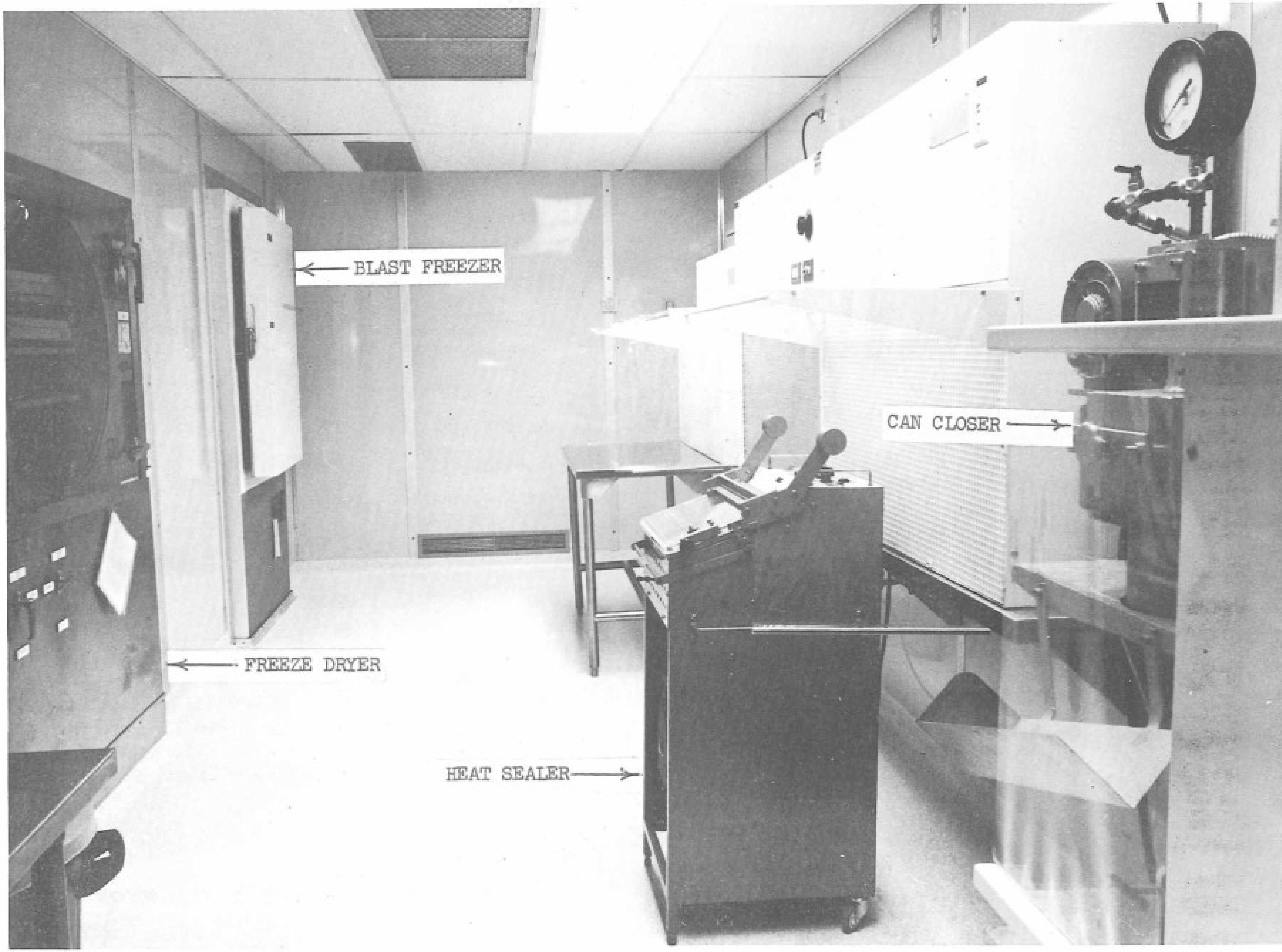

FIGURE 11: Finishing-Packaging Area

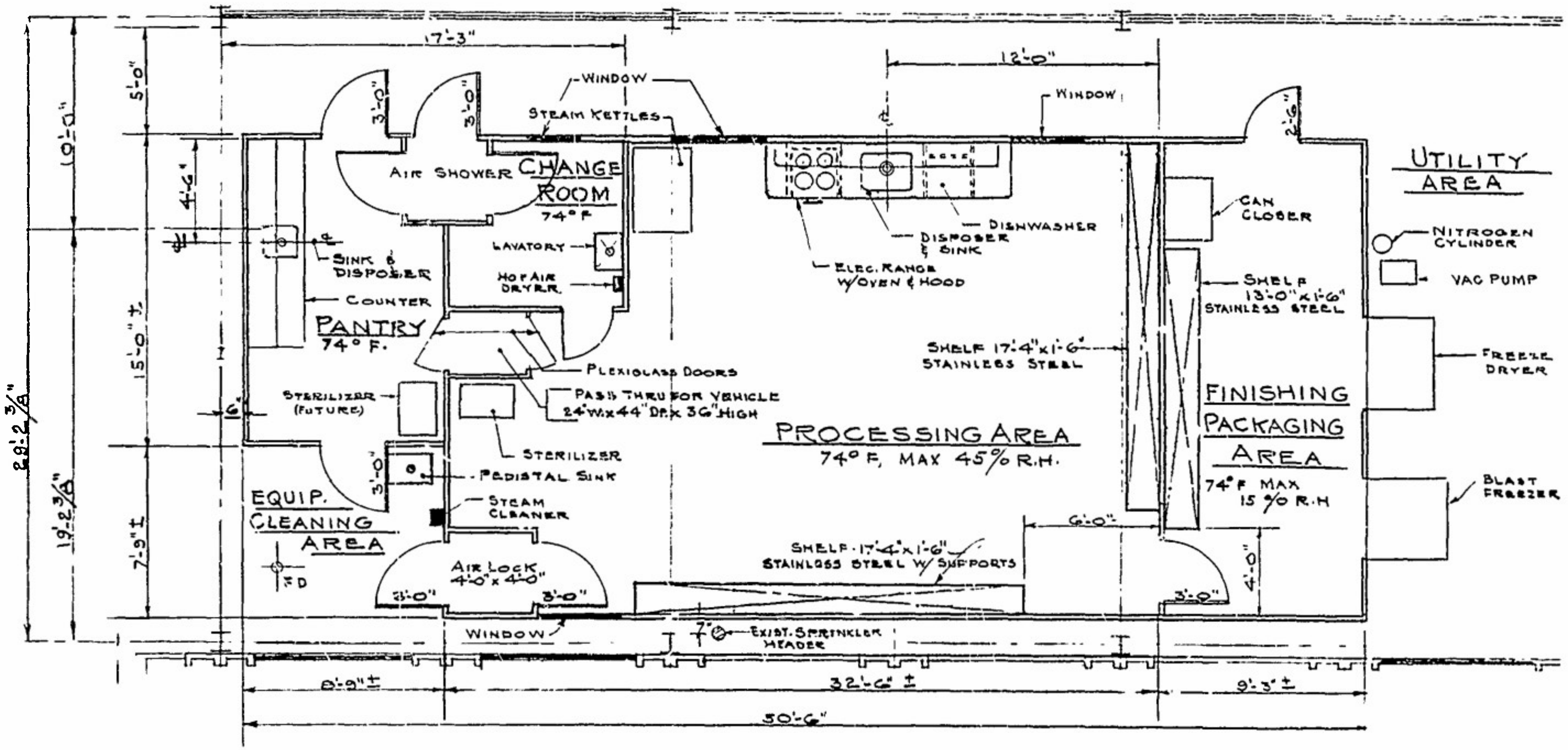

FIGURE 12. LAYOUT OF THE U.S. ARMY NATICK LABORATORIES CONTROLLED ENVIRONMENT FACILITY

Air Filtration:

In describing the pilot installation we mentioned that virtually no biological contamination was observed when the ratio of absolut filter area to room volume was 1 to 57. This was the target for the two critical areas- Processing, and Finishing and Packaging, in the permanent facility. It was achieved and bettered by a combination of absolute filters in the ceiling and by wall-type units mounted on shelving. The relative areas of each and the area to volume ratio for various rooms are:

Room	Area of Ceiling Filters	Area of Wall-type Units	Total area to Volume Ratio
Pantry	8 sq. ft.	-	115
Change	8 sq. ft.	-	49
Processing	24 sq. ft.	72	52
Finishing and Packaging	8 sq. ft.	28	43

In all cases the filters are of the absolute type having a capability of arresting 99.7% of particles 0.3 microns in size and larger. Filtered air is delivered horizontally by the wall-type units at a laminar rate of 90 FPM and vertically through the ceiling filters at around 110 FPM. The air through the ceiling filters is conditioned air, and is recirculated at a rate of about 2500 CFM. This is equivalent to one complete air change in every 3-1/2 to 4 minutes. Outside makeup air is introduced through furnace type filters at 40% of the recirculation rate. Room air is exhausted through a centrally located vent, and if one is to be realistic - through cracks and crevices in the structure itself. The vent is weighed to maintain a positive static pressure of 0.05 inches of water within the facility.

Filter Units:

About the only feature of the wall-type filter units that is novel is the disposable plastic shield, previously mentioned. There are, however, a few details, such as blower and prefilter characteristics and control, which may be of interest. In all but two instances it should mentioned, the absolute filters are 2 feet high, 4 feet wide and 5-7/8 inches in thickness. One of the two exceptions is a 2-ft square unit which is used to provide clean air for the can-closing machine. The other exception is a mobile unit with the 4-foot dimension in a vertical plane. (See Fig.13, p.19).

FIGURE 13: Processing Area

This unit is used for those operations, such as the filling of bite-size molds, which require the increased vertical span. One further general comment, there are nine 2-by 4-foot units in the Processing area and three plus the 2-by 2-ft. unit in the Finishing and Packaging room.

The blowers - two for each 2-by 4-foot filter - are relatively steady flow units with a displacement which ranges from 300 CFM at 1.65 inches static pressure to 530 CFM at 0.78 inches. This is equivalent to a velocity range of 75 to 125 FPM for a 2-by 4-foot filter with a pair of blowers. The range could have been narrowed down by specifying a denser prefilter but a decision was made to spend an extra twenty-five dollars per unit for auto-transformers to regulate the motor speed and obtain positive control of the face velocity.

The prefilter, which is positioned on top of the unit consists of 1-inch Scott Foam having a nominal porosity of 40 pores per inch (PPI). The area of the prefilters on the 2-by 4-foot units is a little under four square feet. In retrospect a prefilter with greater area and denser media is to be preferred. The enclosure is 16-gauge carbon steel with a white acrylic enamel finish. Perhaps 18-gauge material is adequate but the difference in cost is not significant.

3. CONSTRUCTION CHARACTERISTICS

What is noteworthy about the construction of the Natick Laboratories facility is the method of fabrication and this might be considered in some detail. The materials themselves are ordinary off-the shelf items.

Walls, Ceiling and Floor: These represent a major cost of construction where the strategic choice of materials and fabrication techniques are most telling.

The walls consist of prefabricated modular units with 1/8-inch melamine-coated hardboard on the inside. These are bonded to 2-by 3-inch wood framing with $1\frac{1}{2}$-inch space in between filled with self extinguishing block styrofoam insulation. The modules are fitted to level shoes which are anchored to the concrete floor. They are butted together and joined by means of extruded aluminum batten strips. These are shaped to cover the edge of the panels and wedge the adjacent members together. The edges are feathered so that the strips are almost flush with the panel surface. Window areas are sealed with double panes with each pane being flush with its respective wall surface. Inside corners are coved with aluminum molding. To avoid monotony, it was specified that the melanine paneling for each area be of a different pastel color.

The ceiling is 8 feet high and is constructed of 2-by 4-foot metal-faced panels in a suspended "T" bar grid. The panels are loosely positioned in the grid on a gasket of foamed plastic tape. The ceiling tile is 1-inch thick with paper and fiberglass insulation sealed between the thin sheet metal skin.

The floor consists of 0.090 inch sheet vinyl which is cemented to the untreated concrete substrate with waterproof adhesive. It is coved around the perimeter with the vinyl extending up 4 inches to butt against the bottom edge of the melanine paneling.

Utilities: The facility is provided with all the common utilities - electricity, steam, water, sewer drains, compressed air, nitrogen, and vacuum. These are supplied in most cases from overhead connections with the conduit and piping concealed within the wall modules. In the few instances where it was necessary to pierce the wall, the opening around the pipe was sealed with a snug-fitting one-piece aluminum flange which is held in place with epoxy cement. Where the floor was penetrated the space between the sleeve and pipe was sealed with silicone rubber.

Electric power is supplied at 208v. 3ph, 208v. single phase and 115v., through 200 and 100 amp. distribution boards. A liberal number of outlets for these services was specified for each area. This however, was deliberate since it is fruitless to plan for just the right number in just the right location. Furthermore, the installation of an outlet after the facility was completed would involve surface mounting of hardware which could be an unsightly collector of dirt. All outlet boxes are also concealed in the wall with the coverplates being flush with the surrounding surface.

Other utilities worthy of comment:

Nitrogen for packaging is supplied from cylinders outside the facility and is piped to strategic locations with the check valve member of a "quick-connector" at the inside terminal. Piping for compressed air is similarly installed. A short piece of pressure hose with mating quick-connectors is used to connect the equipment to the supply. This arrangement offers added operational flexibility.

Vacuum for the can-closer is provided by a separate vane type pump located outside the facility and remotely controlled from within. The vacuum pump for the heat sealer, which incidentally is an integral part of the unit, turned out to be a problem. A filter was originally installed on the exhaust but it quickly became saturated and allowed the escape of an oily aerosol into the room. The filter was finally removed and the exhaust was piped to the outside.

The specified intensity of illumination was 100-ft. candles at table-top level. This is obtained with fluorescent lighting in flush type fixtures which are supported by the ceiling grid.

Four floor drains are provided, but none are located in the Processing or Finishing areas. The reason is that floor drains are believed to be a potential source of microbiological contamination and that they are not necessary for effective floor sanitation. The installed drains are used around the outside perimeter of the facility to handle condensate from steam traps, cooling water effluent from refrigeration equipment, sweating from evaporator coils, and drippings from steam cleaning and sanitizing of equipment.

No toilet facilities were provided except for a domestic type wash basin in the Change Room.

4. INSTRUMENTATION

The original thought about instrumentation was to keep it to a minimum and as simple as possible. This philosophy only applies in those situations where the requirements are not exacting. Temperature and relative humidity are examples. For the Processing and Finishing-Packaging areas the primary objective was to maintain the temperature in the neighborhood of 74 °F. and this is done with an ordinary thermostatic control. There are no automatic controls for relative humidity. The specified R.H. for the Finishing-Packaging area was 20% or below with no requirement on the lower limit. Two Dryomatic (Model RD150) dehumidifiers are available to satisfy the 20% requirement. Only one is operated during the winter but both are necessary in summer. The relative humidity in the Processing area is not controlled and will range from 50% in the summer to less than 10% in winter. The temperature and humidity are monitored by means of a domestic combination-type thermometer-hygrometer.

The static pressure inside the facility is controlled by a vent with a weighted flapper, and monitored by means of an inclined manometer. Neither the temperature, humidity, or pressure is continuously recorded.

The operation of the filter units is monitored periodically by means of a vane type anemometer. When necessary the average face velocity is adjusted to 90 FPM by changing the setting of the blower speed controller.

The relative level of airborne contamination in the Processing and Finishing-Packaging areas are continuously indicated and recorded by means of a forward, light-scattering photometer. The logarithmic amplifier used in this instrument is not sufficiently sensitive to provide a meaningful indication of contamination at low concentrations. It is planned to replace the logarithmic amplifier with a linear type which will provide the desired sensitivity.

5. OPERATIONAL EQUIPMENT

The Natick Laboratories facility is equipped to formulate, process and package almost any type of food product on an experimental or pilot scale. The equipment ranges in sophistication from ordinary kitchen items to a 12-square-foot freeze-dehydrator. All of it was either designed, specified, fabricated or procured by these Laboratories. Equipment which is fixed in place or which required permanent utility connections was installed by the contractor. All the rest is readily movable and can be arranged for almost any sequence of operations or moved to other areas for cleaning and sanitizing. Items which cannot be hand-carried are mounted on a base with casters.

Perhaps a few comments about the features of major items of equipment is appropriate.

The blast freezer has a usable volume of about 15 cu. ft. and can be operated at temperatures as low as -40°F. Four internal propeller-type fans circulate air across the shelves and through an overhead refrigerant evaporator at a combined rate of about 800 CFM. Of interest might be the door on the back side which permits use of the machine as a supplementary pass-thru and permits defrosting, cleaning and sanitizing without entering a clean area. It is normally locked to prevent its being opened inadvertantly.

The freeze-dehydrator is a condenser-in-chamber machine. A stack of 5 heating platens accommodate 4 trays, having a total area of 12 sq. ft. The stack of platens is boxed on both sides, top and bottom with plate-coil members which provide a total of 24 sq. ft. of vapor condensing surface. A 5 HP semi-hermetic refrigeration unit is used to chill the condenser to as low as -50°F. A 17.7 CFM two-stage pump is used to maintain the system under vacuum.

Both the blast freezer and freeze-dryer are installed with the front of the machine flush with the inside surface of the wall. The back section of the machines are exposed as shown in Figure 14. One advantage of this arrangement is that maintenance work can be done without entering the controlled environment area.

The press is hydraulically-pneumatically operated, which is used to form 1-by 3-inch bars and 11/16-inch cubes. The die cavity is adjustable to accommodate materials of various bulk densities. An overhead pressure-controlled ram generates up to $8\frac{1}{2}$ tons of pressure. The bottom punch is attached to a pneumatic ram which is manually controlled to eject the finished product.

The counters, cabinets and tables were all fabricated to Natick Lab's specifications. The counter-tops and tables are stainless steel while the wall and base cabinets are ordinary steel with a sprayed acrylic enamel finish. Each counter-top has an integral sink which is equipped with a domestic type disposer. The counter in the Processing area has a drop-in type domestic electric range and a built-in institutional type dishwasher.

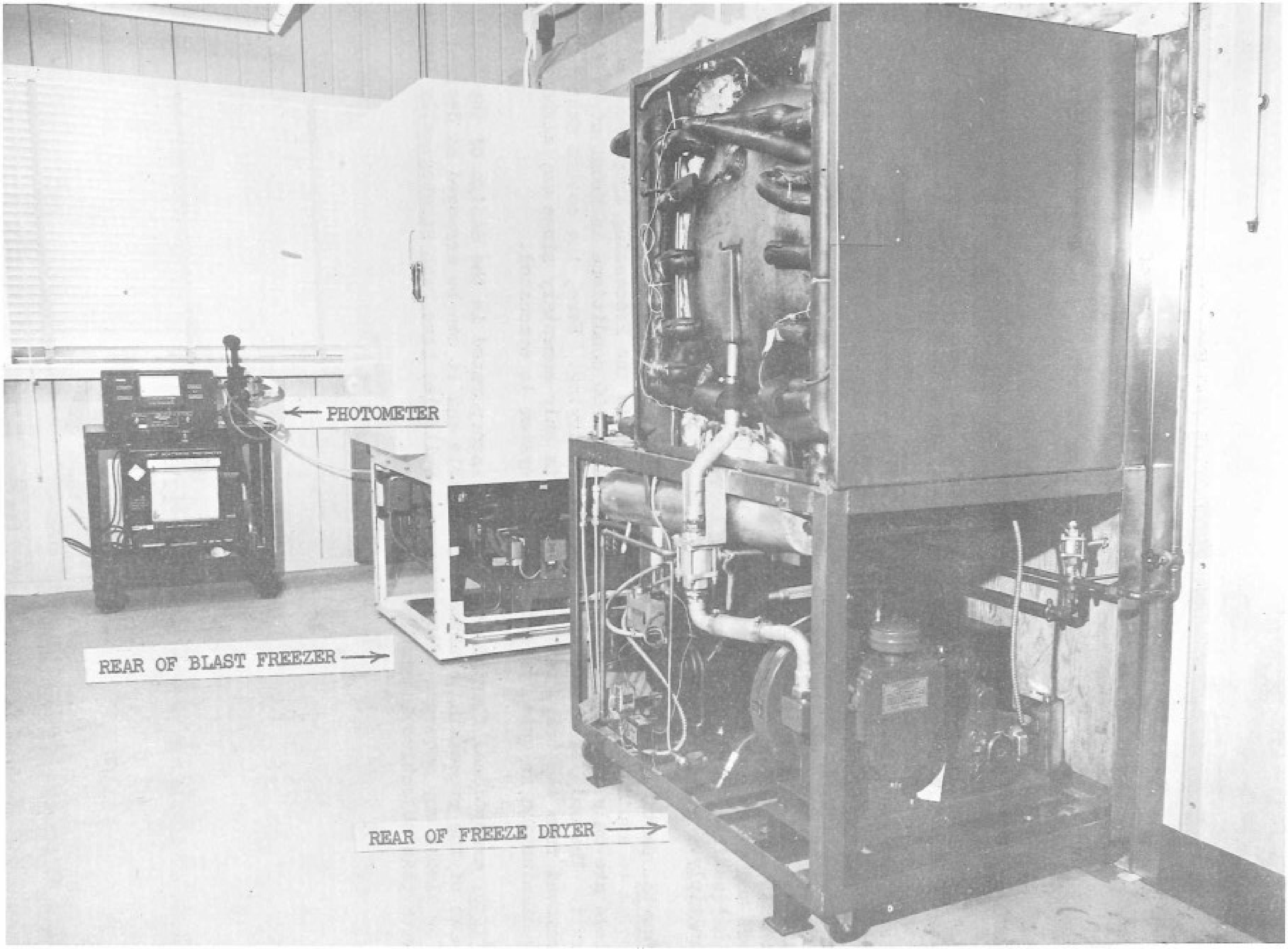

FIGURE 14: Utility Area

6. DISTINCTIVE FEATURES

The merits of our design can be judged on the basis of its meeting certain basic requirements:

First, and perhaps most significant, is the fact that a site was provided and a facility to suit our needs was built and equipped for less than the budget figure.

Second, the design anticipates the possibility of contamination from the spillage of food materials. Thus, the filter units are detached from the adjacent work area and are fitted with disposable plastic shields. The tops of the detached work tables are slightly lower than the shelf on which the filter units are positioned. This arrangement minimizes the chances of introducing contamination from food particles and spillage which might otherwise seep into or under the filter housing. When the shields are soiled they are thrown away.

Third, the facility has been designed to take the guesswork out of cleaning and sanitizing. Every piece of equipment is either movable or open underneath to permit direct access to the floor. Wall surfaces are glassy smooth with fasteners and other hardware being practically flush with the surface. There are no inaccessible ledges or piping where microbial contamination can reside and multiply.

Fourth, particular consideration was given to the handling of food materials so as to avoid airborne contamination. Once in the Processing area, food materials are only exposed to the air under Class 100 conditions in front of a filter unit. The only exception is during freeze-drying. Here, the covers must be removed from the tray, but the exposure is only momentary since any airborne contamination is quickly removed as the system is evacuated.

Fifth, exceptional flexibility has been incorporated in the design of the facility. Most of the processing equipment is movable and it can be arranged as desired for almost any sequence of operations. Utilities have been strategically located with this objective in mind.

A P P E N D I X - Costs

The Clean Room project was initiated late in 1965 with the Air Force and NASA each contributing $50,000. The Army Materiel Command provided the site at a cost of $25,000 and assumed complete responsibility for the engineering, the design, the preparation and monitoring of specifications and the procurement of equipment.

The total tangible costs for the project actually amounted to $115,900, or about $9,000 less than the budgeted figure. Twenty-five thousand dollars of this amount was spent for site preparation; $47,400 for the erection of the facility itself; $42,000 for government furnished equipment and about $1,500 for minor equipment and accessories.

<u>The site preparation</u> involved the installation of a mezzanine floor and stairways in the high bay section of Building 36. The mezzanine floor covers an area of 4,050 square feet and consists of a 2 to $3\frac{1}{2}$-inch thick concrete slab with 6 by 6-inch wire mesh re-enforcing on 12-gauge decking with $1\frac{1}{2}$-inch channels. The low bid for this phase of the project was $21,950. Charges for engineering, inspection, and extras, brought the total to just under $25,000.

<u>The low bid for the controlled environment facility itself</u> was $47,400 or about $47 per square feet of floor area. This figure included the installation of all the equipment furnished by the government.

Perhaps the $47 per sq. ft. is misleading since it is based on total area rather than being limited to the area of the Processing and Finishing-Packaging areas where contamination is rigidly controlled. The unit cost on this basis is $57 per sq. ft. This figure was obtained by pro-rating the cost of the facility on the basis of area; by adding $7,670 for the filter units and then dividing the total by the combined area of the Processing and Finishing-Packaging areas.

<u>Major items of government-furnished equipment</u> are listed in Table I, pp. 29 and 30.

Accessories and minor equipment include ordinary kitchen items and miscellaneous furnishings such as a sticky mat, vacuum cleaner, stool, glass shelving, coat racks, step-stand, etc.

TABLE I: MAJOR EQUIPMENT

ITEM	MAKER OR TRADE NAME	MODEL	SIZE OR CAPACITY
Pot Rack	Progressive	SSO-3	30 sq. ft.
Can Closer	Rooney Machine Co.	-	8 CPM
Filler	Filler Machine Co.	Geyer CH	-
Heat Sealer	Mo-Vac	No. 12	-
Refrigerators (2)	Frigidaire	FPCD-205TP	20 cu. ft.
Filter Units (12)	Pure-Aire	-	8 sq. ft.
Filter Unit	Matthews Res.	-	4 sq. ft.
Blast Freezer	Haskris Co.	-	17 cu. ft.
Scale	Penn Scale Co.	10/10	10 kg.
Mixer w/Attach.	Kitchen Aid	K5-A	5 qt.
Mixer w/Attach.	Hobart	AS200T	20 qt.
Freeze-Dryer	Thermovac*	50-CIT-MOD	12.2 sq. ft.
Meat Saw	Globe	79	-
Meat Chopper	Hobart	4812	-
Meat Slicer	U.S. Slicing Machine	HCX	-
Press	NLABS	-	8½ tons
Steam Cooker	Market Forge	ST-AS	-
Vacuum Pump	Gast	2565	21 CFM
Steam Kettles w/Table	Groen-NLABS	(TDC20) (TD240)	(20 qt.) (40 qt.)

*Reworked by U.S. Army Natick Laboratories.

TABLE I: MAJOR EQUIPMENT (cont'd)

ITEM	MAKER OR TRADE NAME	MODEL	SIZE OR CAPACITY
S.S. Tables (2)	Linsey - NLABS	-	2 by 4 feet
Counter w/Disposer, Range & Dishwasher	Linsey - NLABS	-	11 by $2\frac{1}{2}$ ft
Counter w/Disposer	Linsey - NLABS	-	9 by $2\frac{1}{2}$ ft
Wall Cabinets (2)	Linsey - NLABS	-	-